CAI formed and place a firm upper limit on the abundance of $^{41}K^*$, ⟨ 1 ppb. In contrast, $^{26}Mg^*$ is ; 5 ppm in these CAI. The near absence of $^{41}K^*$ requires either that $^{41}K^*$ was lost during CAI metamorphism or that the time interval between ^{41}Ca production and CAI formation was $\sim 2 \times 10^6$ y, an interval fully compatible with that inferred from ^{26}Al.

HAW, 1981. *LPS XII*, 381.
HAW, 1984. *LPX XV*, 387.

Mg ISOTOPIC STUDIES OF LEOVILLE "COMPACT" TYPE A CAI

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One long-standing problem in the application of Al-Mg isotopic systematics to the chronology of CAI is the enigmatic Mg isotopic record of hibonite. Hibonite (ideally, $CaAl_{12}O_{19}$) is one of the first major element bearing phases to appear in the condensation sequence [1] and occurs as a major constituent only in CAI whose bulk composition is considerably more refractory than Allende Type B1 CAI. The Mg isotopic composition of hibonite, however, fails to reflect its presumed early origin with $^{26}Mg^*/^{27}Al$ ranging from $\sim 7 \times 10^{-5}$ to $< 2 \times 10^{-7}$ [2,3]. Hibonite is abundant in two "compact" Type A CAI (CTA) from Leoville and we have begun a petrographic and Mg isotopic study of coexisting phases to investigate the degree to which events of formation and metamorphism are reflected in the Mg isotopic record.

Leoville 575 (described in [4]) and 776 are both large elongated CTA's comprised predominantly of melilite (mel) (Åk ~ 3-30) enclosing abundant hibonite (hib) and spinel. Large (up to ~ 1 mm) mel laths in 575 are highly kink-banded and evidence of pervasive cataclastic deformation is extensive. Hib occurs as bladed and blocky crystals (up to ~ 100 μm) intimately intergrown with spinel. Minor polycrystalline plagioclase (plag) (up to ~ 20 μm) is also present. Mel in 776 occurs as smaller (50-300 μm) relatively strain free equant crystals with 120° triple grain boundaries. Hib is strongly pleochroic and occurs as clusters of 10-20 μm crystals often bounded by spinel. The general fabric appears to reflect metamoprphic recrystallization.

Both CAI have similar Mg isotopic patterns with hib containing much larger ^{26}Mg excesses (up to 75‰ in 575 and 16‰ in 776) than coexisting mel or plag. ^{26}Mg excesses in hib in both CAI are well correlated with $^{27}Al/^{24}Mg$ and all data lie along a correlation line with slope $^{26}Mg^*/^{27}Al = 5 \times 10^{-5}$, characteristic of Allende Type B1 CAI. Mel and plag in 575 also contain $^{26}Mg^*$ but these data fall well below the hib line and define a linear array with slope $^{26}Mg^*/^{27}Al = 3 \times 10^{-5}$. Mel in 776 contains no $^{26}Mg^*$ with $^{26}Mg^*/^{27}Al < 1.5 \times 10^{-5}$. The isotopic and petrologic data from these two CTA and a previously analyzed Allende CTA [2] suggest that CTA formed contemporaneously with Allende B1 CAI with uniform $^{26}Al/^{27}Al \sim 5 \times 10^{-5}$ in all phases. Subsequent metamorphism affected CTA to varying degrees and caused partial (in 575 and 3529-26 [2]) or complete (in 776) re-equilibration of the Al-Mg system. The petrologic evidence of greater recrystallization in 776 is consistent with the more extensive isotopic re-equilibration obscured in 776. Hib in CTA appears to be more resistant to element redistribution than either plag or mel.

	Leoville 575		Leoville 776	
	$\delta^{26}Mg$(‰)	$^{27}Al/^{24}Mg$	$\delta^{26}Mg$(‰)	$^{27}Al/^{24}Mg$
Hb1	25 ± 4	56 ± 1	6 ± 3	18 ± 1
2	41 ± 4	100 ± 2	10 ± 2	30 ± 2
3A	56 ± 5	143 ± 5	16 ± 3	42 ± 2
3B	75 ± 7	201 ± 6	—	—
Ml1	10 ± 4	36 ± 2	0 ± 2	12 ± 1
2	20 ± 3	57 ± 3	0 ± 2	15 ± 1
Pg1	34 ± 12	173 ± 10	—	—

[1] *GCA* **36**, 597 (1972).

[2] *ACS Symp.* **176**, 95 (1982).
[3] *Ap. J.* **228**, L93 (1979).
[4] Kracher *et al.*, 1984. Sub. to *GCA*.

CHONDRULES IN THE BISHUNPUR LL3 CHONDRITE

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Twenty-six chondrules, chondrule fragments or clasts were analysed by microprobe. An automated wavelength dispersive instrument with a 90 μm beam integrated a series of analyses in traverses across each object. Depending on the size of the cross-sectional area, from 1 to 24 analyses were performed for each bulk analysis. Si, Ti, Al, Cr, Fe, Ni, Mn, Mg, Ca, Na, K and S were determined, and an analysed augite was used as a secondary standard before and after each set of analyses. The work is part of a study of chondrule rims, interchondrule matrix, chondrules and clasts in unequilibrated ordinary chondrites.

Only two of the twenty-six objects analysed have Ca/Al atomic ratios greater than the ordinary chondritic average of 0.74; this is true for three of nineteen chondrules analysed by McSween (1977). The bulk meteorite has a normal Ca/Al ratio (from Dodd *et al.*, 1967), so presumably a Ca-rich, Al-poor component must be present to compensate for chondrules and clasts (Fig. 1). This component is unlikely to be rim or matrix (Hutchison and Bevan, 1983), but may be phosphate associated with metal or sulphide. Na/Al ratios range from 1 to almost zero, but there is no hiatus as in a suite of Manych chondrules and glasses (Hutchison and Bevan, 1983). Representatives of a noritic suite of chondrules and clasts (Hutchison and Bevan, 1983) are probably present in Bishunpur, but here they grade towards others with normal ordinary chondritic normative feldspar.

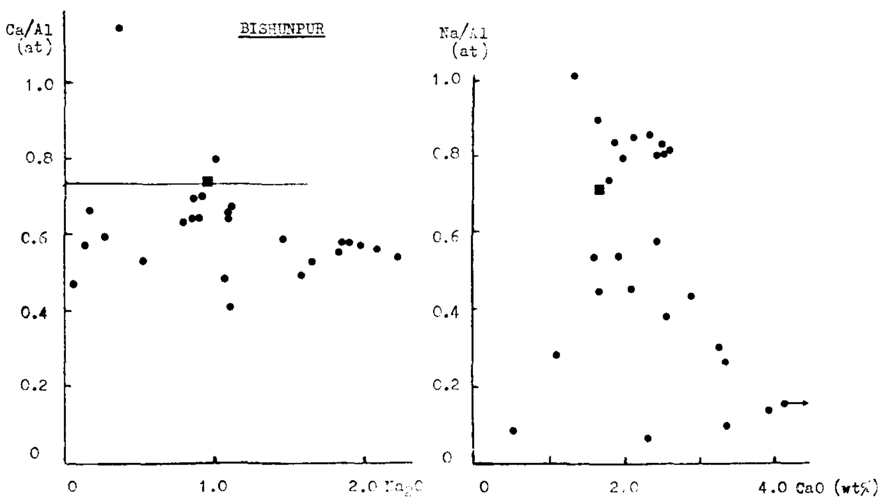

Fig. 1 **Ca/Al (atomic) ratio vs Na_2O (wt %) and Na/Al (atomic) vs CaO (wt %) in 26 objects in Bishunpur (Analyst: R. Hutchison). The horizontal line represents the ordinary chondritic Ca/Al ratio. Squares: bulk meteorite (Hutchison and Bevan, 1983).**

Dodd, R.T., W.R. Van Schmus, and D.M. Koffman, 1967. *Geochim. Cosmochim. Acta* **31**, 921-951.